

# **The VSS CCD photometry spreadsheet**

## **Introduction**

This Excel spreadsheet has been developed and tested by the BAA VSS for analysing results files produced by the multi-image CCD photometry procedure in AIP4Win v2. It uses an ensemble magnitude calculation, which means that multiple comparison stars can be used to calculate the magnitude of the variable star. These instructions relate to version B2.03 of the spreadsheet although they are expected to be valid for any version starting B2.

## **Purpose**

The purpose of the spreadsheet is threefold. It lets you examine the content and quality of your data quickly and so helps you to improve your observing technique. It provides a convenient way of recording all the relevant information about an observing run in one place for future reference, which is important if the data is to be of scientific use. And finally, it makes it very easy to submit your results to the BAA, the AAVSO or another organisation as part of an observing programme.

The spreadsheet is intended for use with time-series differential photometry measurements of a single object (plus comparison and check stars) recorded with either no filter or a single photometric filter (eg U, B, V, R or I).

Mostly the spreadsheet is self-explanatory if you spend a few minutes looking through it carefully. In particular, note the colour-coding of the various cells in the ObsvEqmt and Results sheets. This tells you which cells you must fill in (**red font**) about you and your equipment, your observing site, the objects being observed, and the observing session, which cells are optional (**blue font**) and which cells the spreadsheet fills in automatically (**green font**). Some of the information, for example about your observing site and equipment, will only need to be filled in the first time you use the spreadsheet and can then be copied for subsequent observing sessions. The information about the objects being measured will obviously need to be added each time, or you can just save several copies of the spreadsheet setup for different stars. The cells containing calculations are password protected so you won't be able to accidentally change the formulae.

## **General Excel Notes**

The spreadsheet has been tested successfully in Excel 2003 to Excel 2010, and it is expected to work in future versions of Excel as Microsoft usually makes releases backwards compatible. However, it may not work with Excel clones like OpenOffice and Kingsoft.

You may need to alter your Macro security as the spreadsheet buttons use Visual Basic. This may sound a little daunting but this is explained below.

### *Enabling Macros in Excel 2007 and Later*

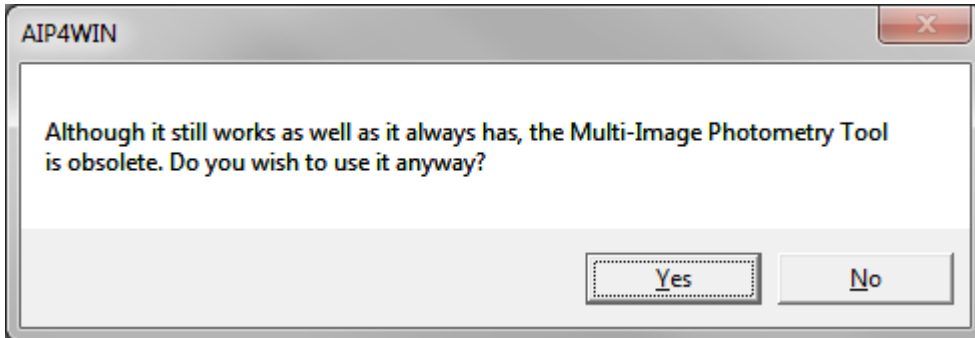
In Excel bring up the Options menu. (*The location of Options varies in different versions of Excel but it can normally be found by the left most menu bar for File or the Windows button.*) Next select Trust Center (last option on left hand side). Click the Trust Center Settings button. Then select the Macro Settings. Set "Enable all macros" and click OK.

### *Enabling Macros in Excel 2003*

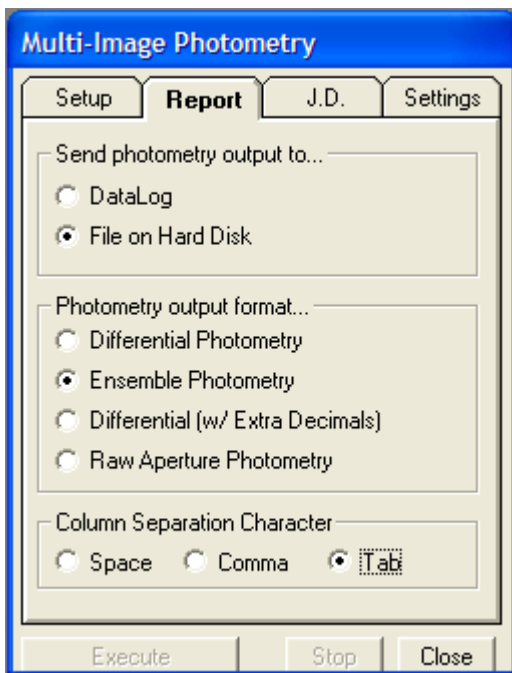
In Excel select the Tools menu, then Macros and finally Security. Set "Enable all macros" and click OK.

## **AIP4Win Settings**

The spreadsheet is designed to work with the Multi-Image Photometry Tool, found in the Measure menu of AIP4Win. Note that you may see the below message when selecting this Tool. You should simply click Yes to the message.



Here is a screenshot of the settings to select in the Multi Image Photometry Tool to create an output file that is compatible with the VSS CCD photometry spreadsheet.



## **Sheet Explanations**

Below are a few words of explanation about each sheet in the spreadsheet.

### *Buttons sheet*

This contains buttons to select input and output files, and to process the data. The button text is self-explanatory and the file names and paths can be manually changed should you wish to do so, noting that the folder must already exist! There are also some basic instructions at the bottom of the sheet under the buttons.

### *ObsvEqmt sheet*

This sheet contains information about you, your location and your equipment. The **red** font text should be populated as it is used in the output files that go to the BAA VSS and the AAVSO.

### *Results sheet*

This is the main sheet of the spreadsheet and the one you are likely to use most. You must enter information in the cells with a **red** font about the variable star, the chart, and the comparison stars. Some information in green font comes from the AIP4Win data file or is calculated.

It is worth emphasizing that if the chart/sequence you are using gives no error values for the comparison stars, then the Reference Error column should be left blank (column G in version B2.03 of the spreadsheet). You should avoid typing zero for the error as this will be treated as though the reference magnitude is exact, which it will never be. Instead type 0.001 if the quoted error is zero. The Results and Data Checks columns (columns H to O) are especially useful. They can tell you whether or not the comparison star magnitude used in the ensemble are in line with the chart/sequence magnitude (column O), as well as the average weight of a comparison star in the ensemble (column K).

The really useful part of the whole spreadsheet is you can select and deselect comparison stars from the ensemble (column E) to see what effect this has on the calculation. You may need to recalculate the spreadsheet after setting a comparison star to Yes or No, and this can be done by pressing F9, but usually calculation is set to automatic.

If you make any changes then you must press the button to regenerate the charts, BAAVSS sheet, and the AAVSO sheet.

### *Calculation sheet*

You need not concern yourself with this sheet as it is the ensemble magnitude calculation. It is visible if you are interested in seeing how the calculation works, but be warned it is not for the faint hearted!

### *CalcAAVSO sheet*

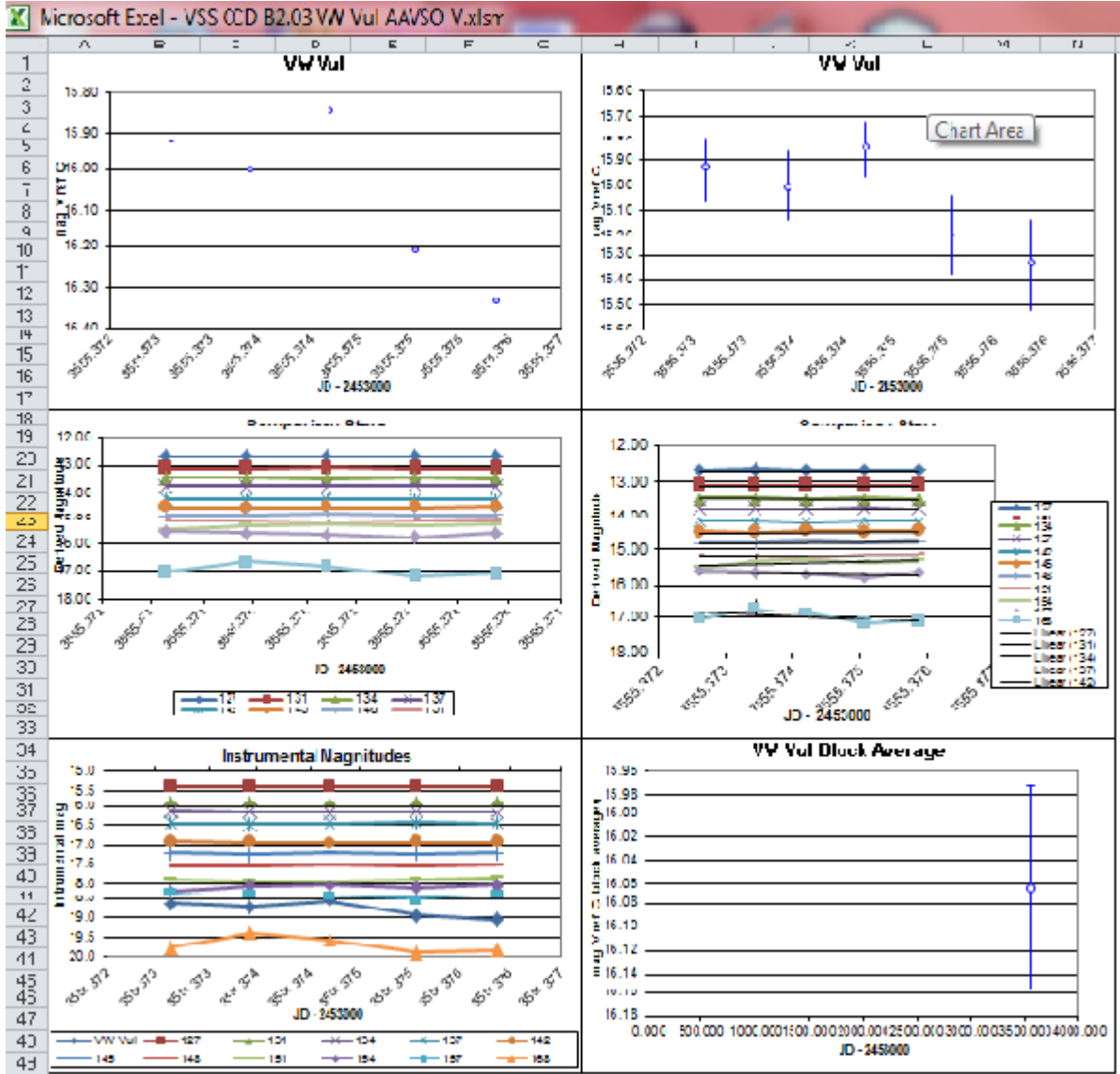
Almost identical to the Calculation sheet. The only difference is that if a star is selected as Check in the Results sheet, then it does not form part of the ensemble in the CalcAAVSO sheet, but does form part of the ensemble in the Calculation sheet.

### *Data charts sheet*

The Data charts sheet is useful for seeing at a glance what your data looks like. There are plots of the measured variable star magnitude (mag V ref C), the derived comparison star magnitudes, and the raw instrumental magnitudes. The charts on the left hand side do not include error bars to make the points easier to see, while on the right hand side the charts include error bars.

Just to the right of the charts are some settings you can adjust if you wish to bypass the chart automated minimum and maximum axes values, and to alter the rounding of the minimum and maximum axes calculation.

Examples of these plots are shown below.



### BAAVSS sheet

This sheet contains a copy of the data file that is produced for the BAA VSS.

### AAVSO sheet

This sheet contains a copy of the data files that is produced for the AAVSO.

### Image sheet

The Image sheet is optional and provides somewhere for you to store an image of the field with the stars you selected in AIP4WIN. This is very good practice as it provides an unequivocal way of remembering which stars you actually measured.

### Data sheet

This sheet contains a copy of the AIP4Win data file.

### Version Log sheet

This contains a list of the different versions of the CCD spreadsheet, along with a brief explanation of the changes.

## The Ensemble Calculation

Below is some optional reading on the ensemble calculation.

### General Notes on the Spreadsheet Formulae

- The formulae in the Results and Calculation sheets are completely recreated each time data is imported.
- De-selecting a star in the Results sheet (setting 'Include in Analysis' to No) changes the results of all the formulae so they no longer include this star (no need to re-import the data). However, it should be noted that to change which stars are in the graphs, the data must be re-imported with only the required stars selected.

### The Ensemble Formulae

#### Intermediate Calculations - Zero Point Magnitudes and Errors

ZPMagnitude = Reference Magnitude – Instrumental Magnitude

$$ZPError = \sqrt{\text{Reference Error}^2 + \text{Instrumental Error}^2}$$

Both of these are multiplied by either 0 or 1 in the spreadsheet formula to exclude or include them in the analysis.

#### Derived Magnitude and Errors

$$\text{Derived Magnitude} = \text{Instrumental Magnitude} + \frac{\sum_1^n \text{ZPMagnitudes}}{n}$$

$$\text{Derived Error} = \frac{\sqrt{\sum_1^n \text{ZPError}^2}}{\sqrt{n}}$$

Here n is the number of comparison stars used in the analysis. So if you have measurement of 10 comparisons but only choose to use 5 in the analysis, then n is set to 5 within the spreadsheet formulae.